

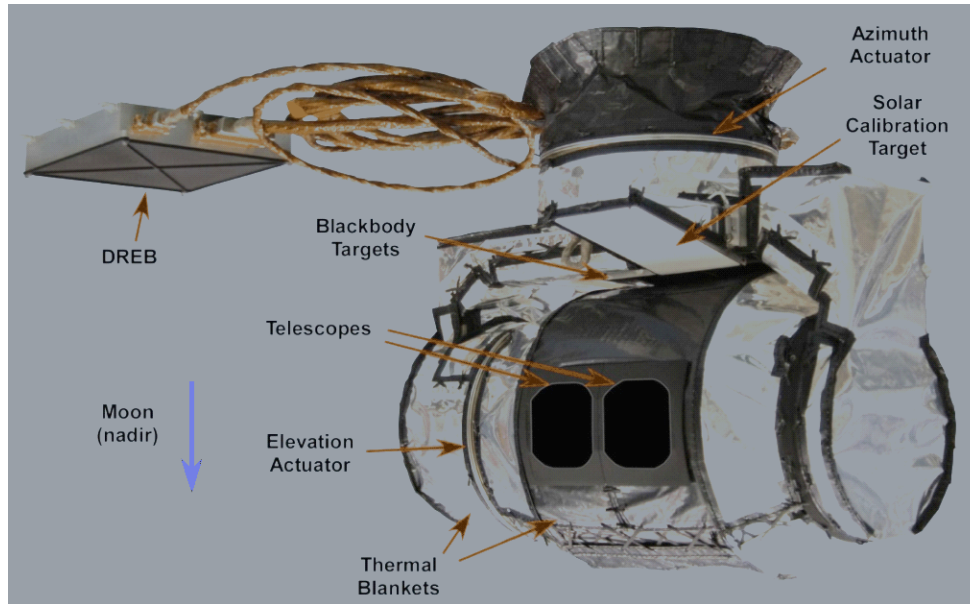


**LRO DIVINER SOIL  
COMPOSITION  
MEASUREMENTS –  
LUNAR SAMPLE  
“GROUND TRUTH”**

**Carlton Allen – JSC  
Ben Greenhagen –  
JPL**

**David Paige – UCLA**

# LRO Diviner Overview



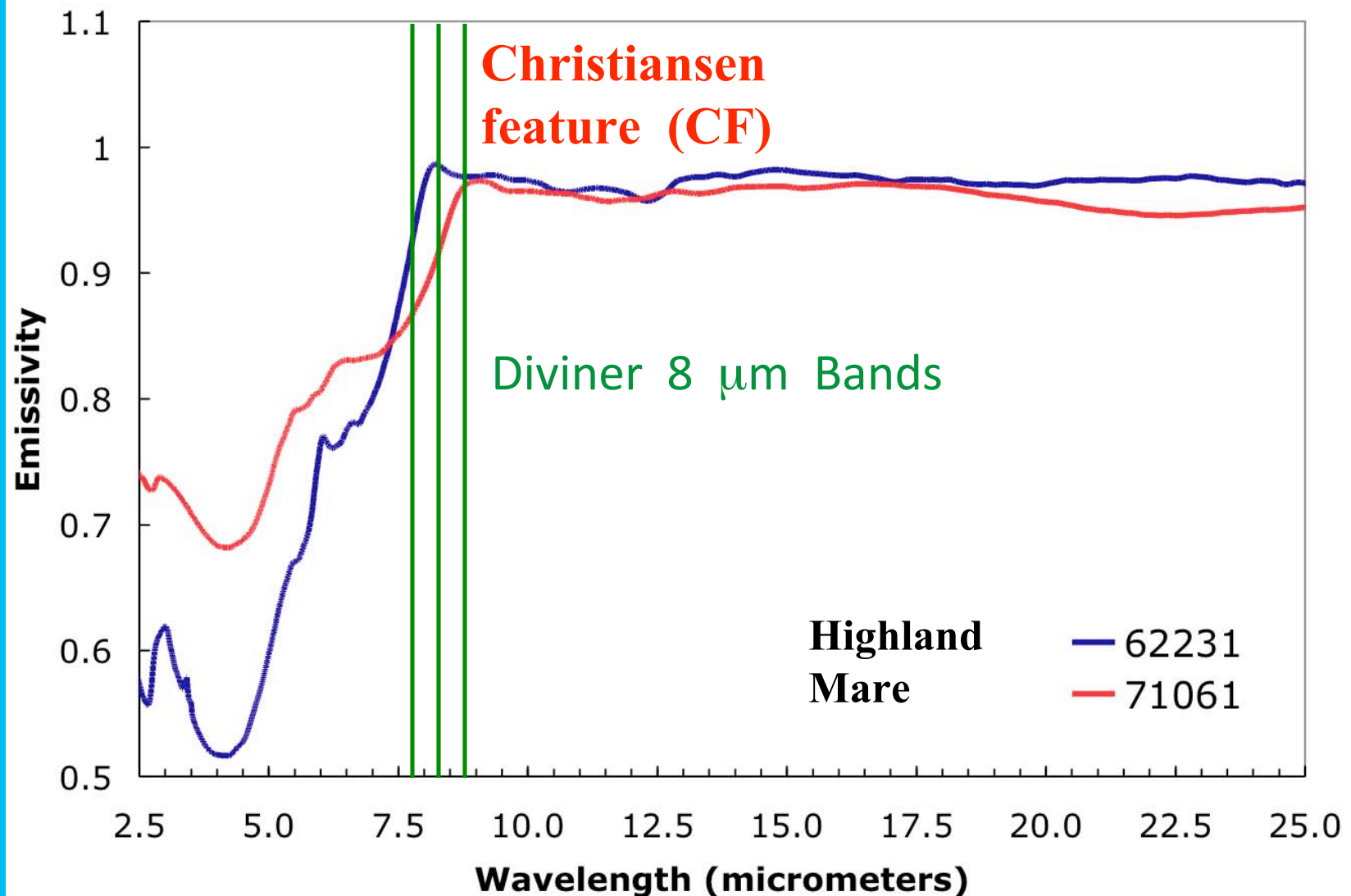
Observation Strategy	Primarily nadir pushbroom mapping
Detectors	Nine 21 -element linear arrays of uncooled thermopile detectors
Fields of view	<p>Detector Geometric IFOV:</p> <p>6.7 mrad in-track</p> <p>3.4 mrad cross-track</p> <p>320 m on ground in track for 50 km altitude</p> <p>160 m on ground cross track for 50 km altitude</p> <p>Swath Width (Center to center of extreme pixels):</p> <p>67 mrad ; 3.4 km on ground for 50 km altitude</p>

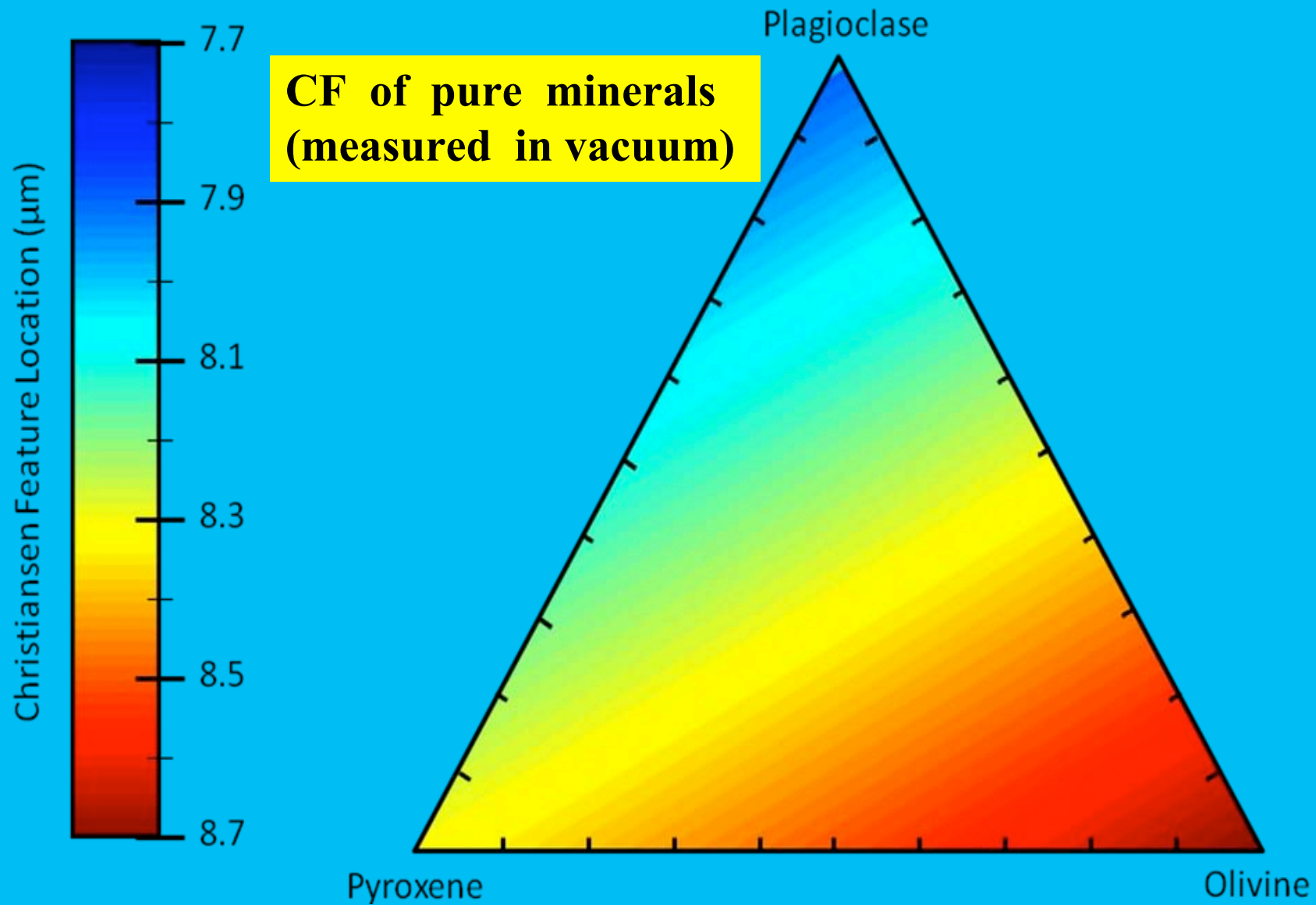
## Science Goals

1. Characterize the Moon's surface thermal environments:
  - Daytime
  - Nighttime
  - Polar
2. Map properties of the lunar surface:
  - Bulk thermal properties
  - Rock abundance
  - Composition
3. Characterize polar cold traps:



## Measuring mineralogy from orbit in the thermal IR

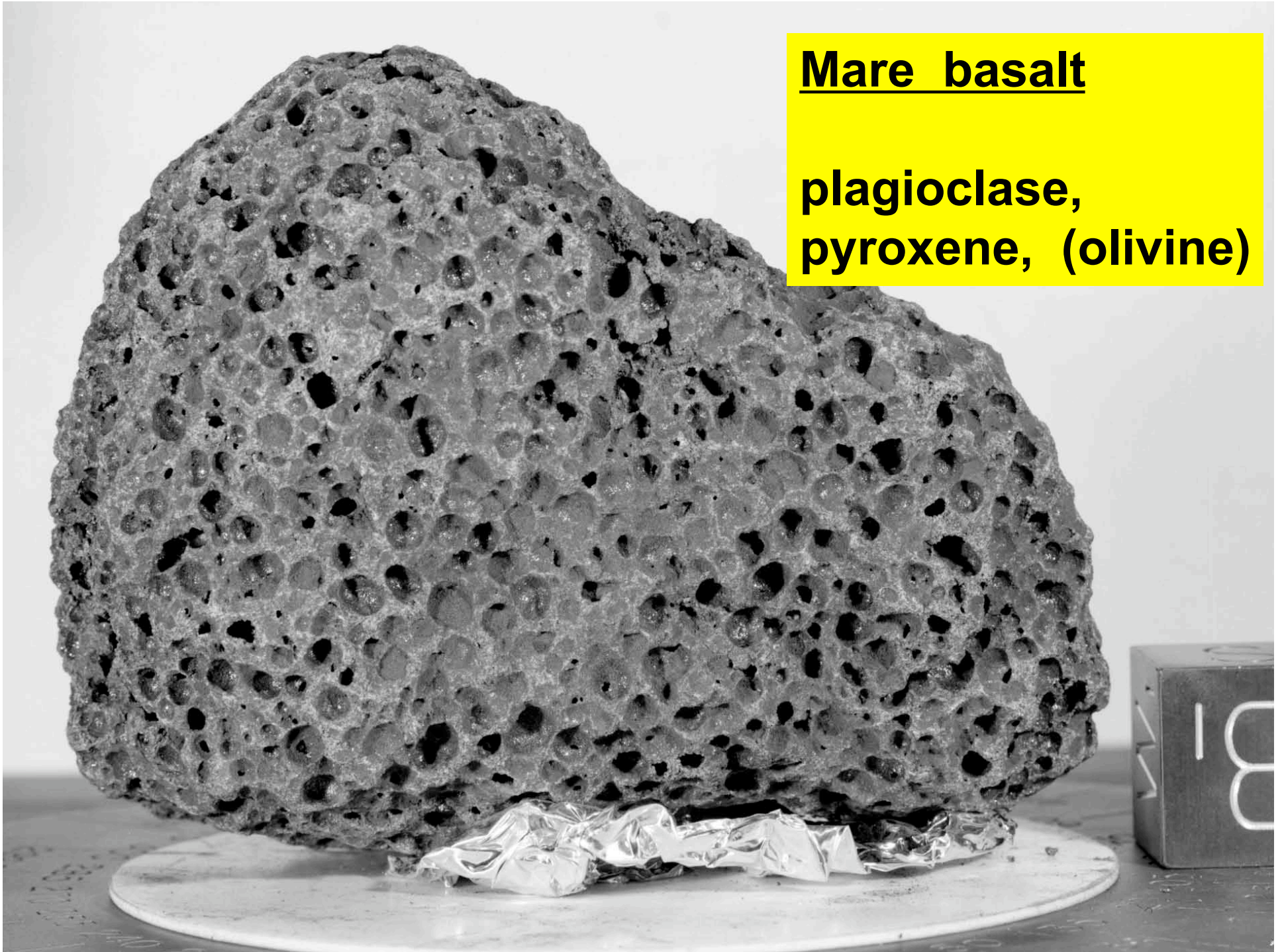






**Mare basalt**

**plagioclase,  
pyroxene, (olivine)**

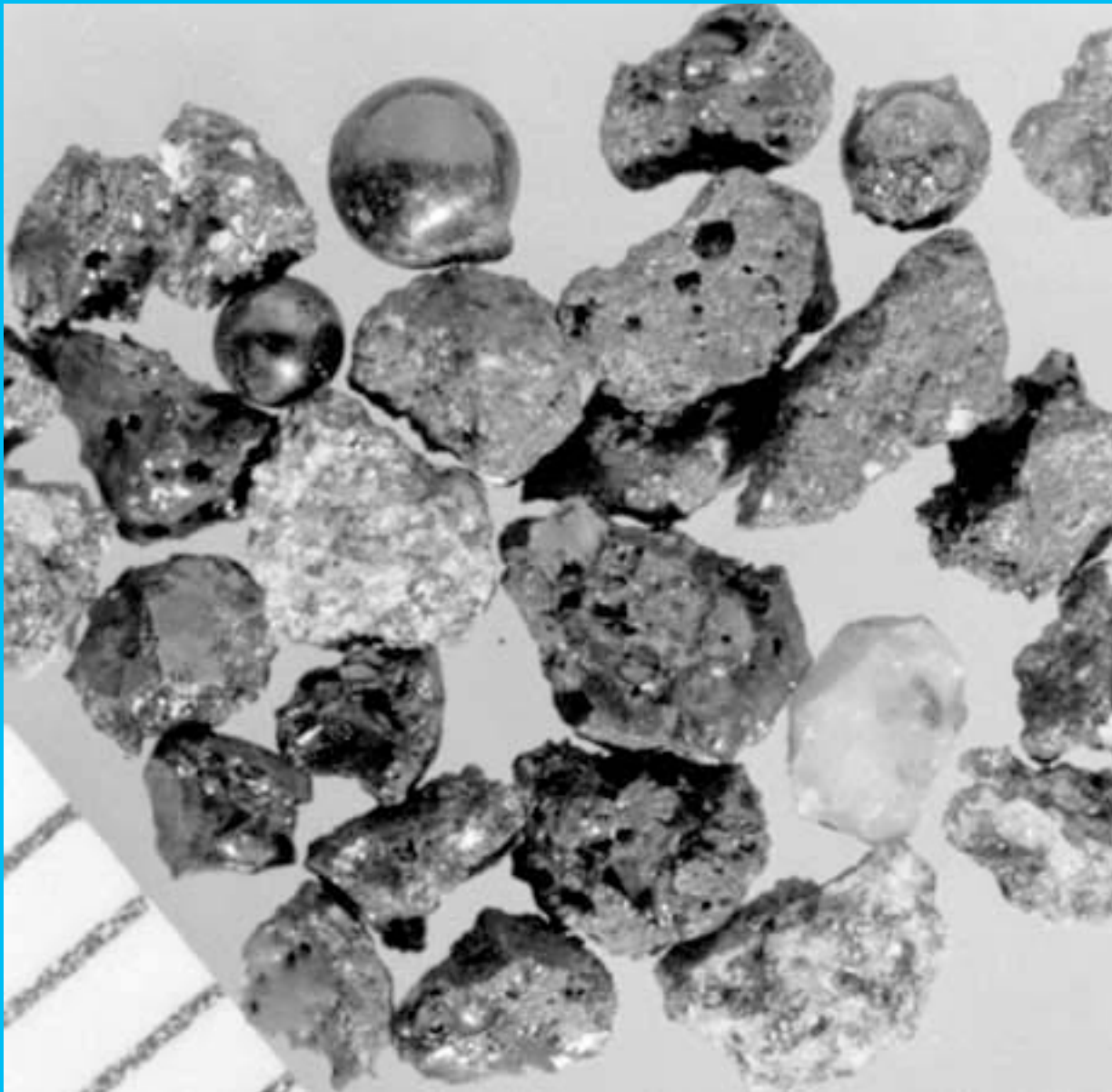


# Highlands anorthosite

mostly plagioclase







## Lunar soil

**Physical  
mixture of  
fine-scale rock  
and glass  
(impact and  
volcanic)**

1 mm



**How well do  
Diviner CF  
values  
correlate with  
Apollo surface  
compositions ?**



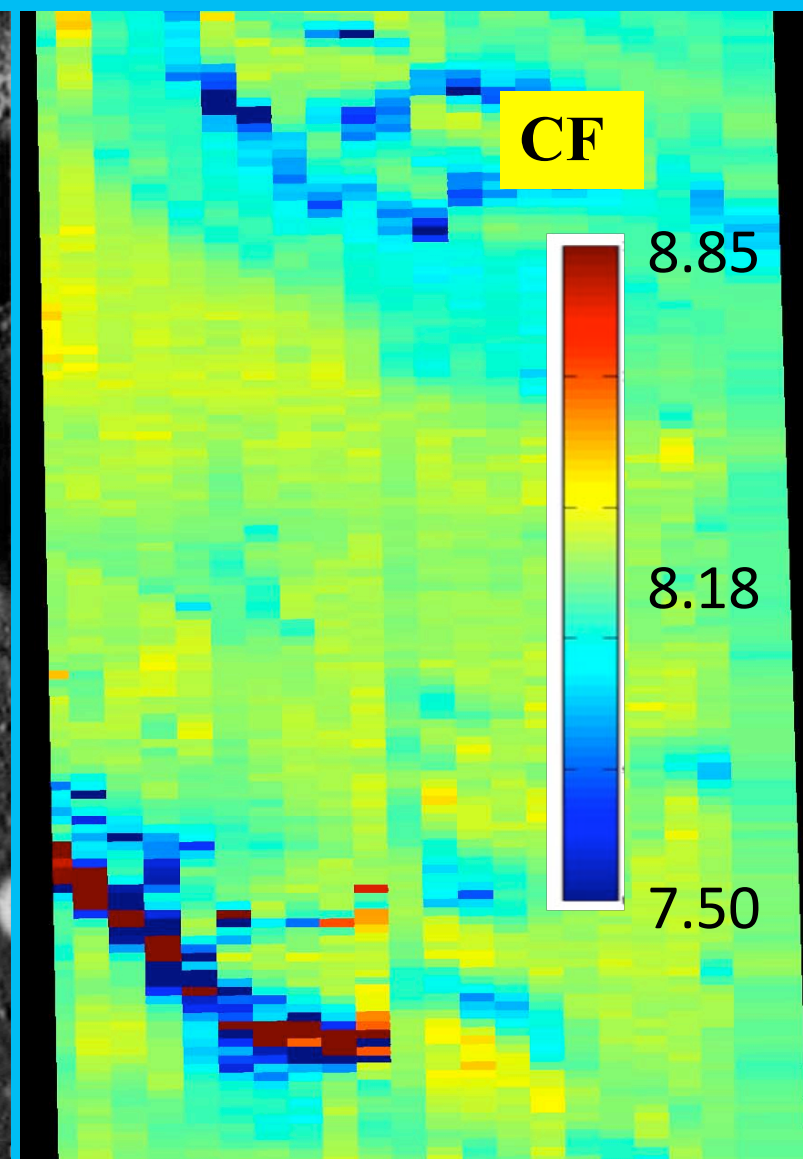
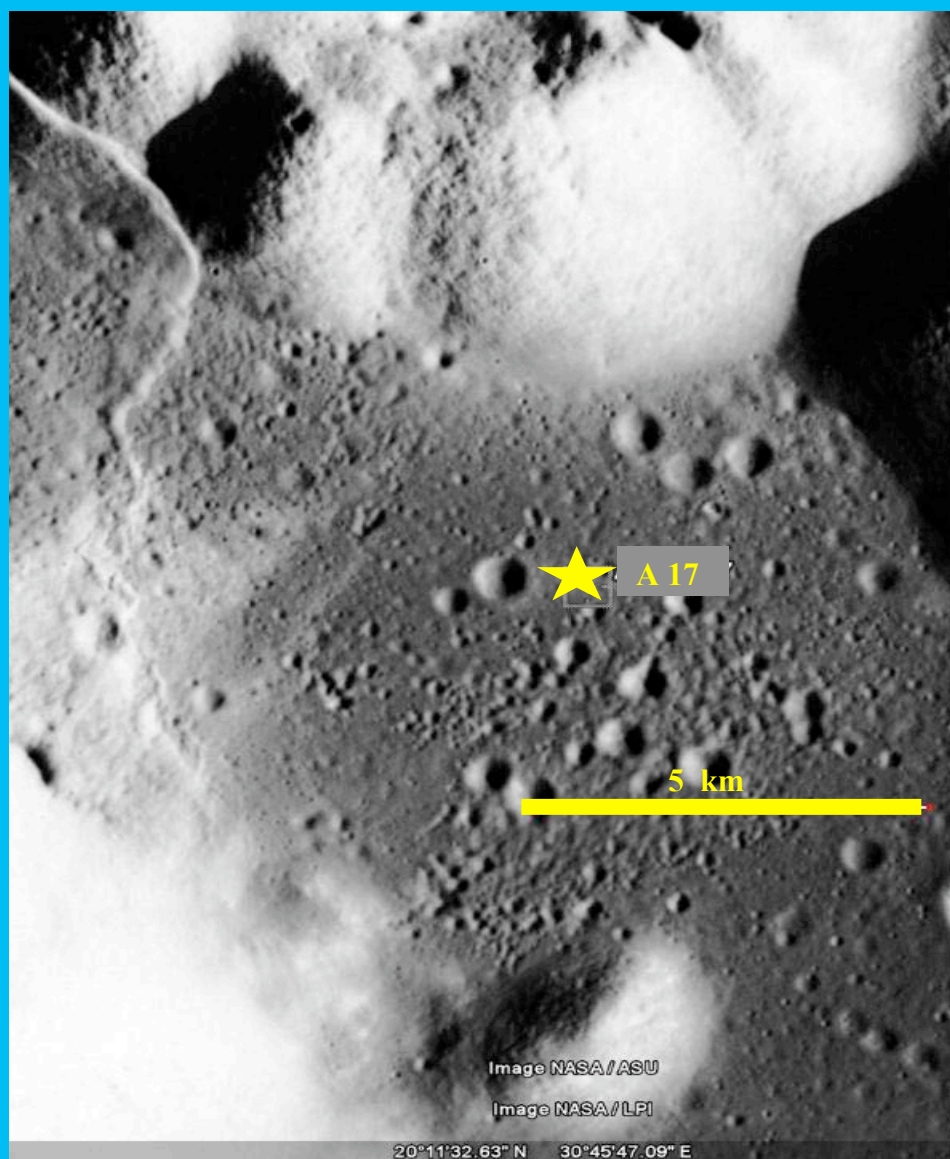


**Ground truth –**

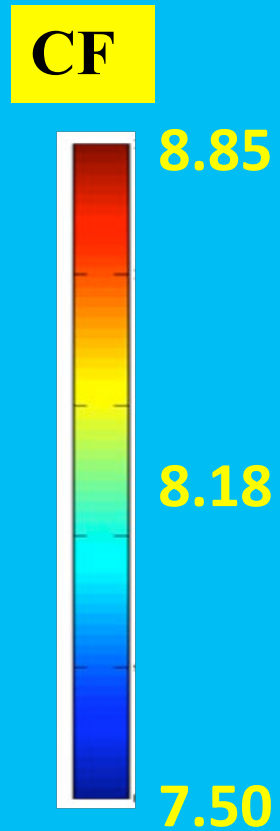
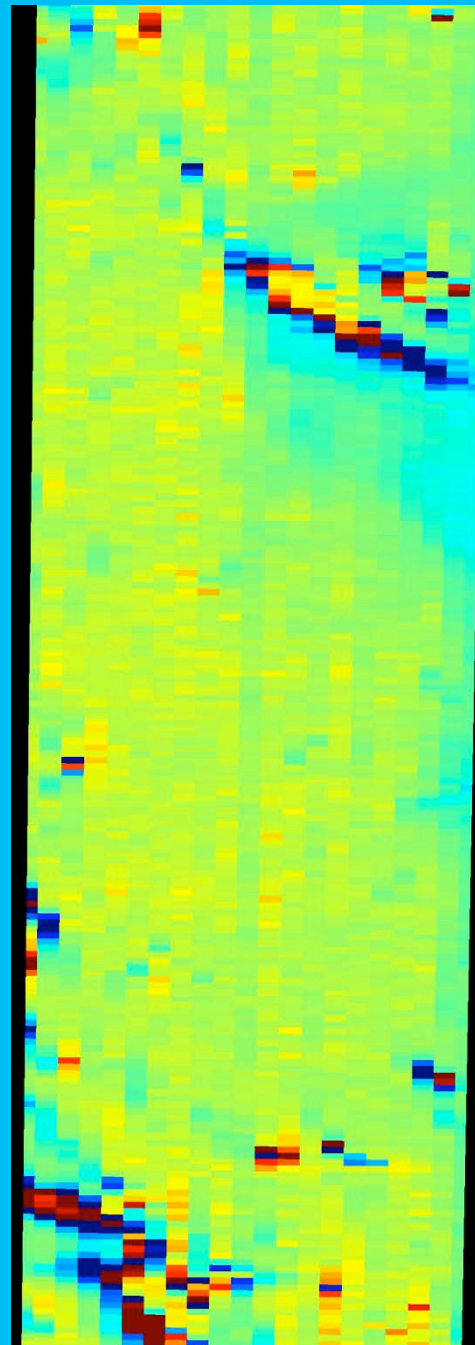
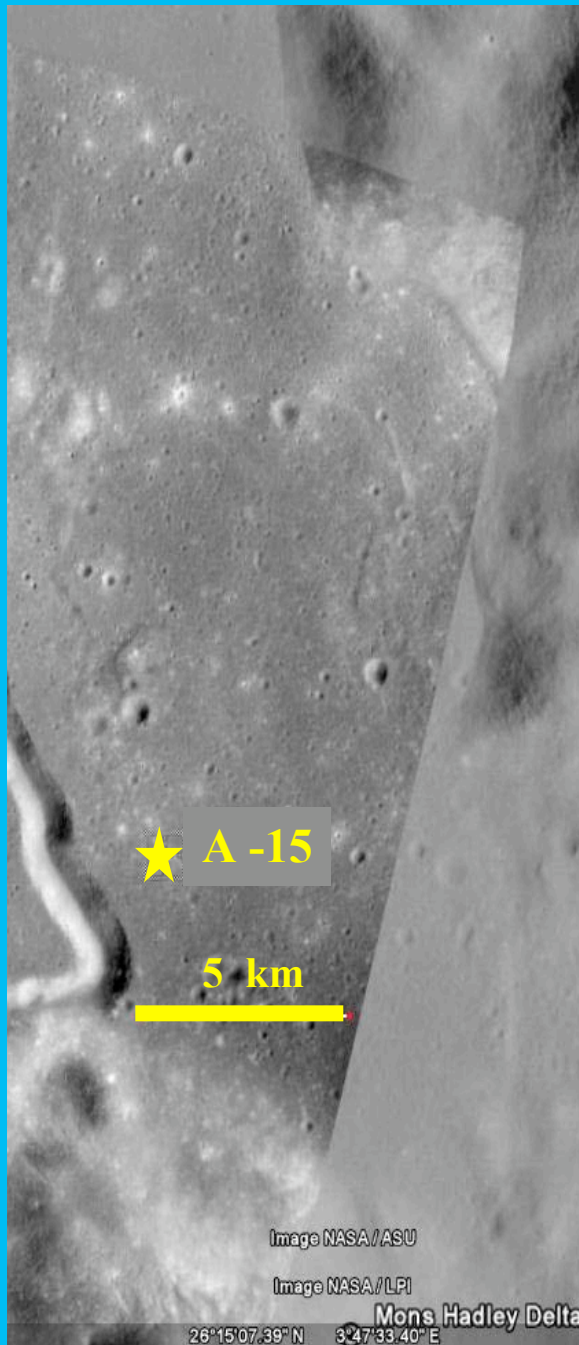
**Lunar surfaces are dominated by soil and rocks.**

**Lunar soils closely approximate the compositions of underlying rocks.**

**Apollo 15**

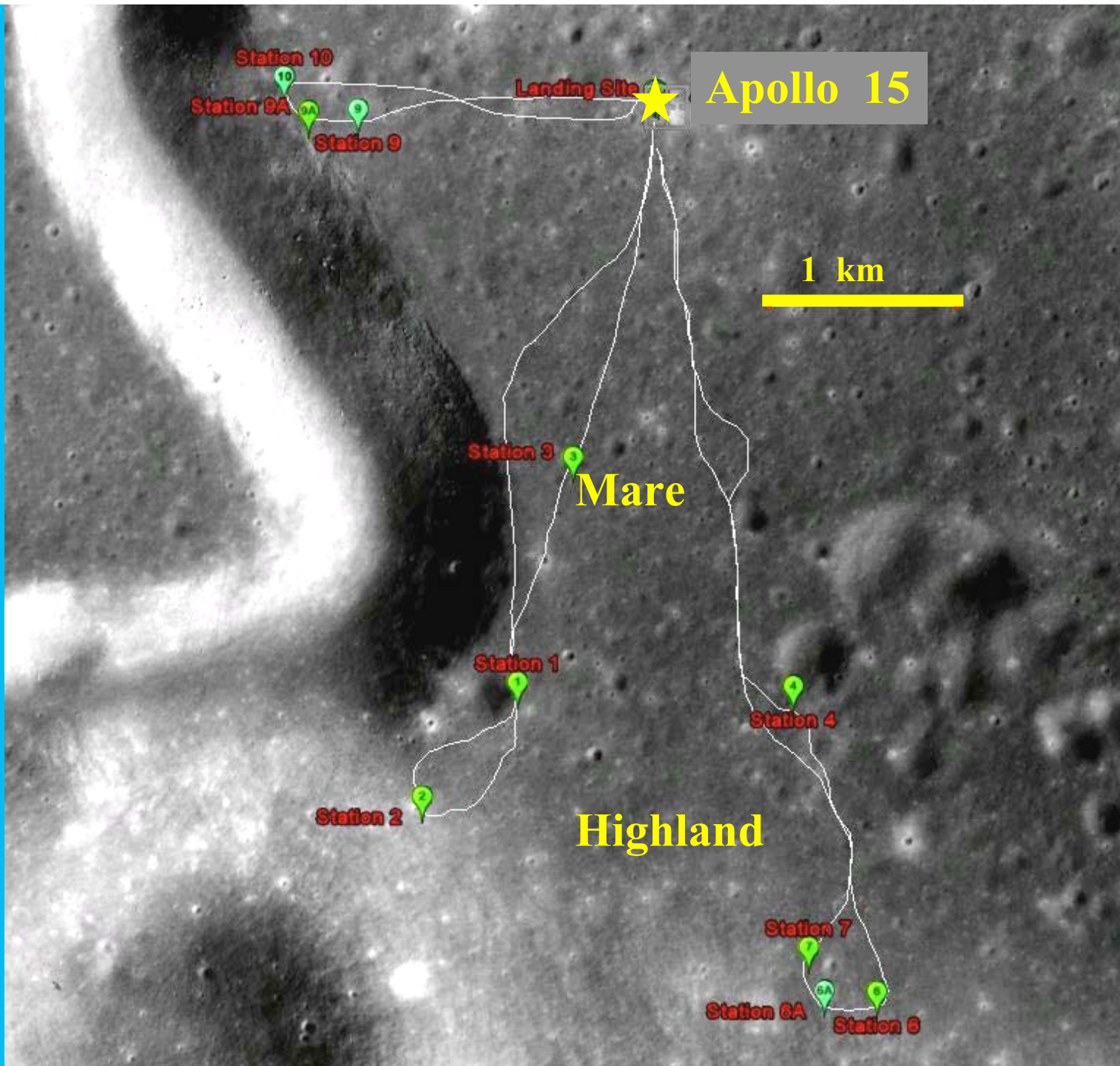






**CF varies with  
topography and  
mineralogy**





Apollo 15

Landing Site

1 km

Mare

Highland

Station 10  
Station 9A  
Station 9

Station 3

Station 1

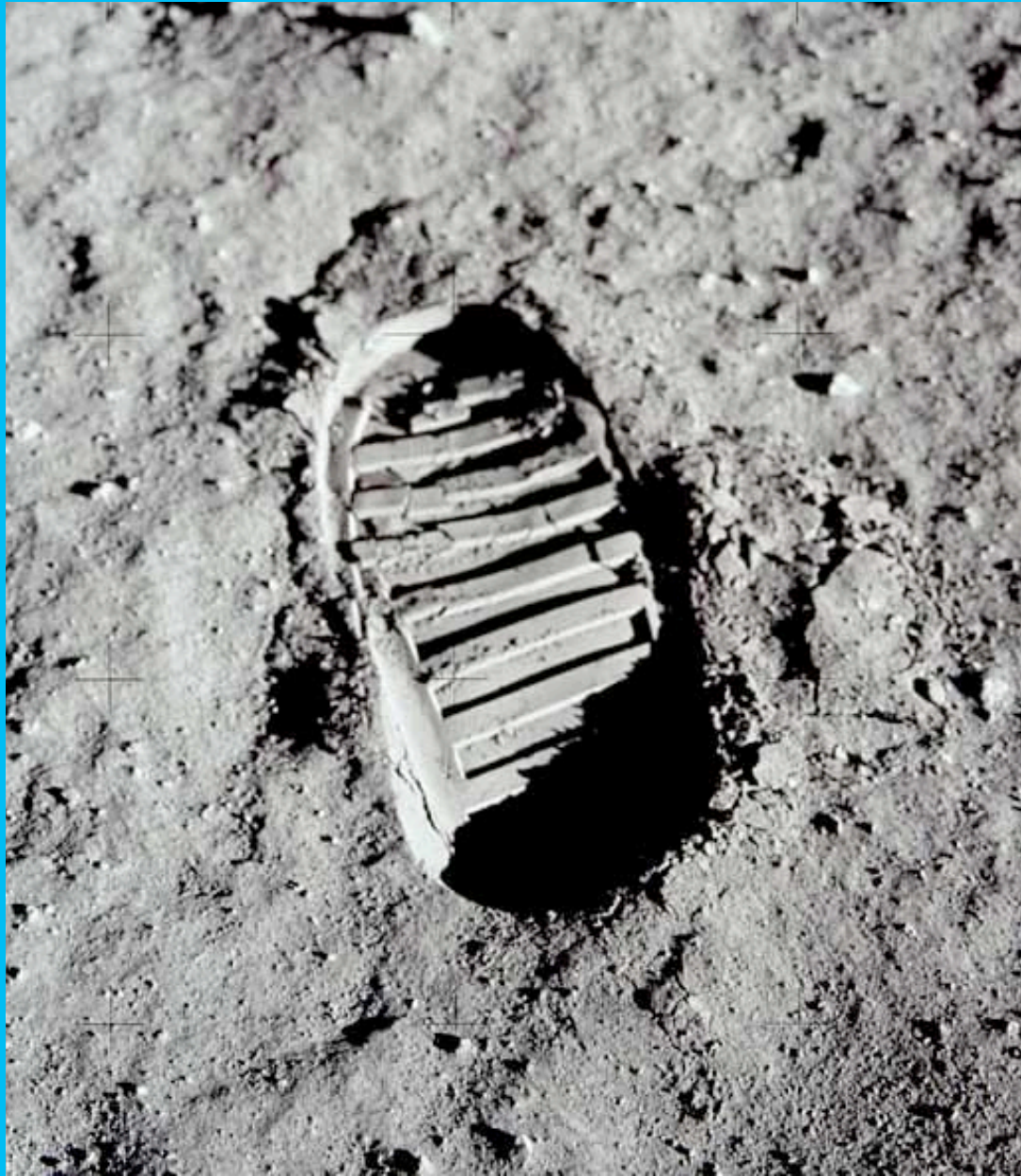
Station 2

Station 4

Station 7

Station 6A

Station 6



**What data are representative of Apollo landing site soil compositions ?**

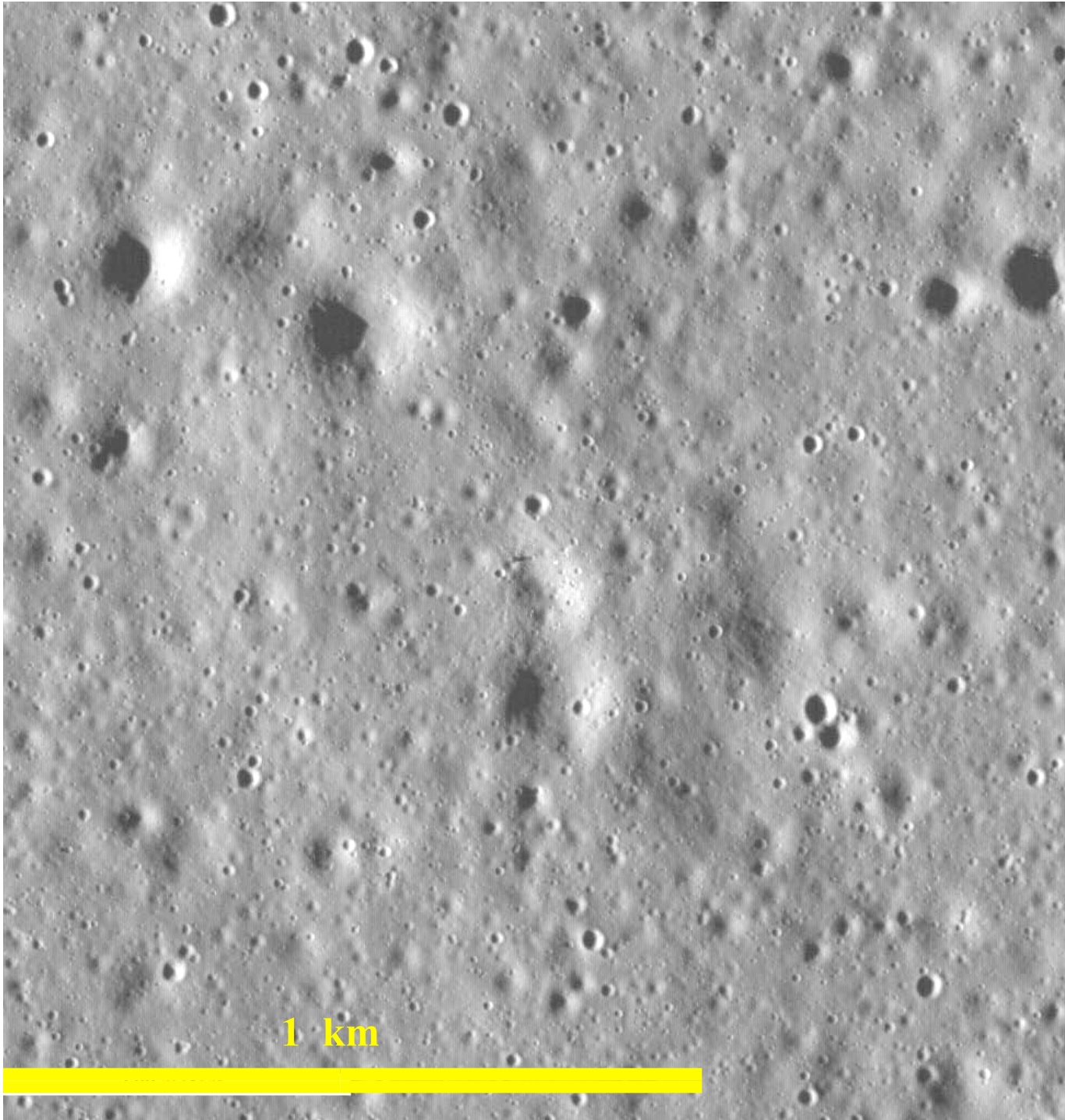
- **Oxide Abundances**
- **Modal Mineralogy**

**Taylor *et al* (2001; 2009)**

## **Representative Lunar Soils**

<b>SITE</b>	<b>SAMPLE</b>	<b>I<sub>s</sub>/FeO</b>
<b>Apollo 11</b>	<b>10084</b>	<b>78</b>
<b>Apollo 12</b>	<b>12001</b>	<b>56</b>
<b>Apollo 14</b>	<b>14259</b>	<b>85</b>
<b>Apollo 15</b>	<b>15071</b>	<b>52</b>
<b>Apollo 16</b>	<b>61141</b>	<b>56</b>
<b>Apollo 17</b>	<b>70181</b>	<b>47</b>





**Apollo sites  
relatively  
flat, smooth,  
and uniform  
at the km  
scale**

**Apollo 15**

**LROC**

<b>SITE</b>	<b>DATE (2009)</b>	<b>MEAN CF VALUE (<math>\mu\text{m}</math>)</b>
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<b>Apollo 11</b>	<b>10/29</b>	<b>8.33</b>
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<b>Apollo 12</b>	<b>10/5</b>	<b>8.30</b>
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<b>Apollo 14</b>	<b>11/1</b>	<b>8.24</b>
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<b>Apollo 15</b>	<b>9/6</b>	<b>8.32</b>
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<b>Apollo 15</b>	<b>10/3</b>	<b>8.33</b>
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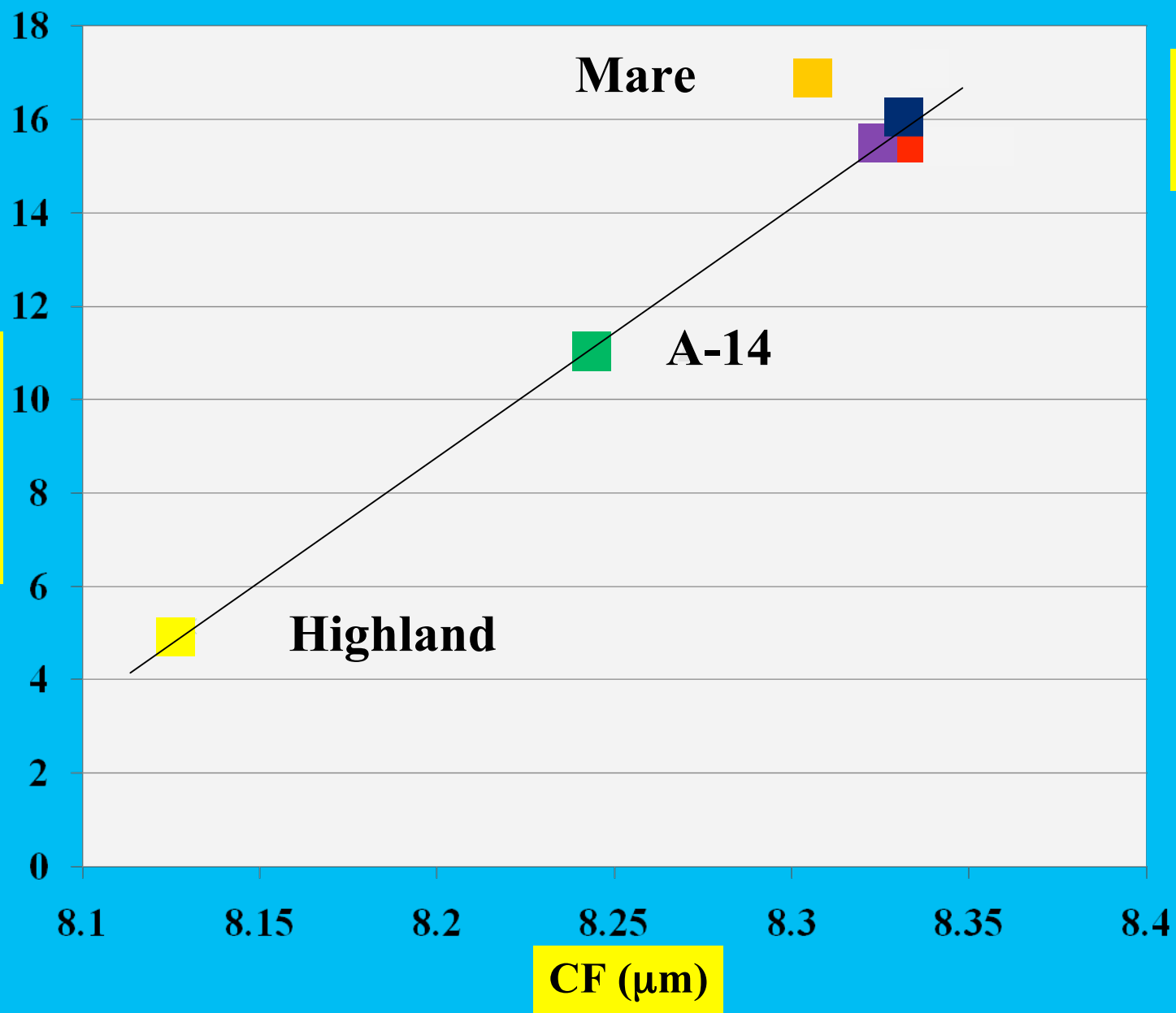
<b>Apollo 16</b>	<b>9/5</b>	<b>8.12</b>
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<b>Apollo 17</b>	<b>9/4</b>	<b>8.33</b>
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**2 X 2 km  
around each  
landing site**

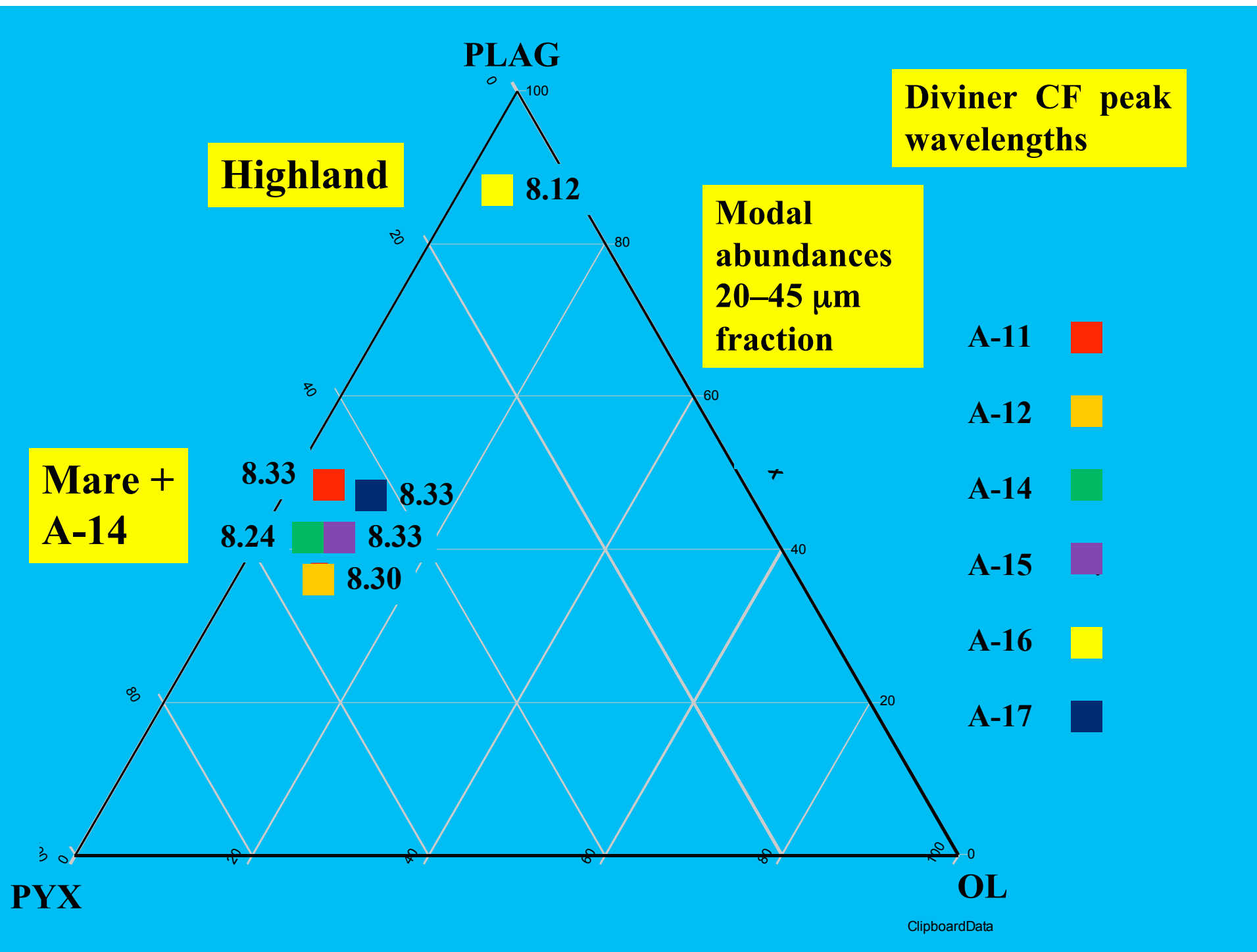
20-45  $\mu\text{m}$   
fraction

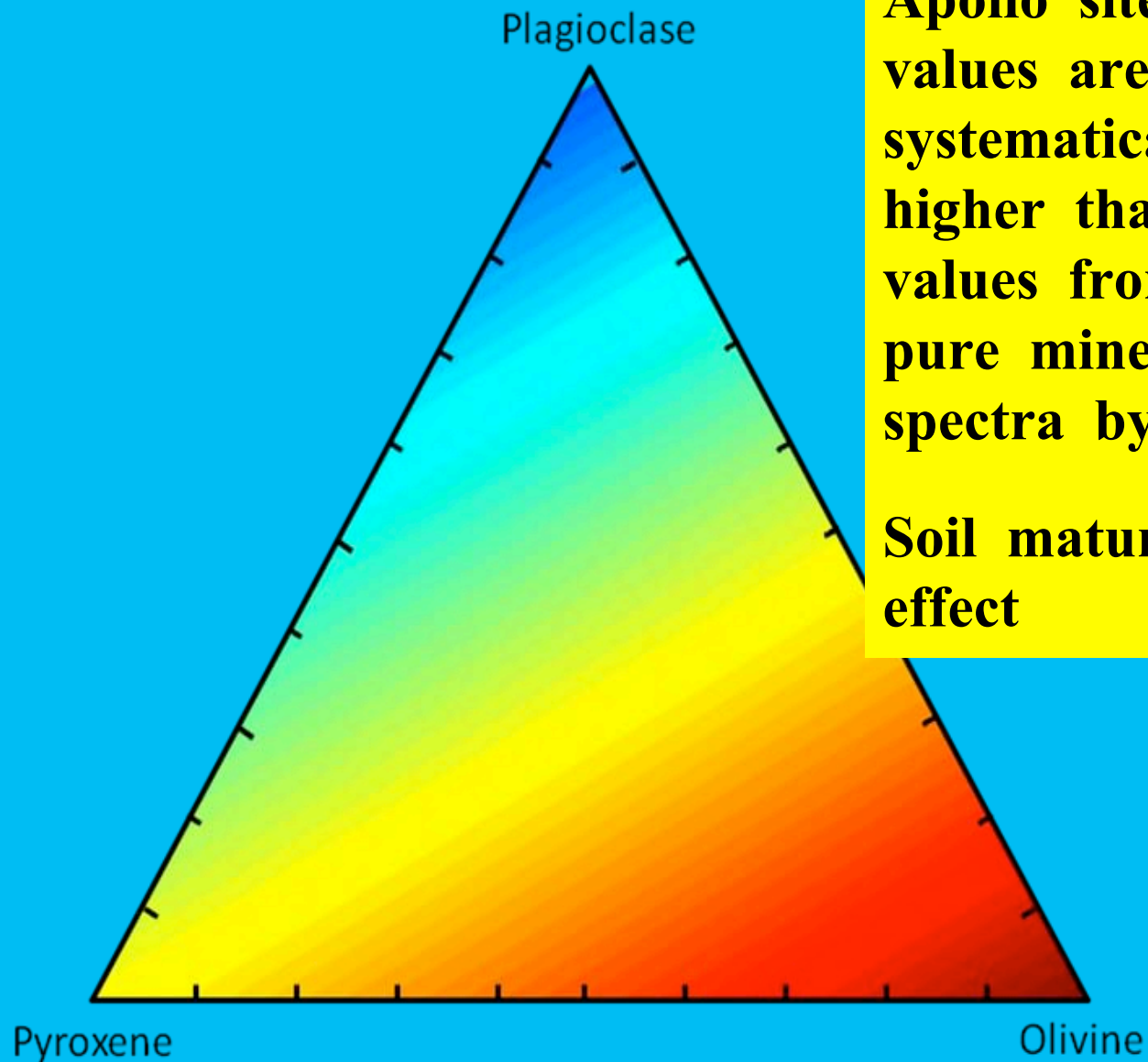
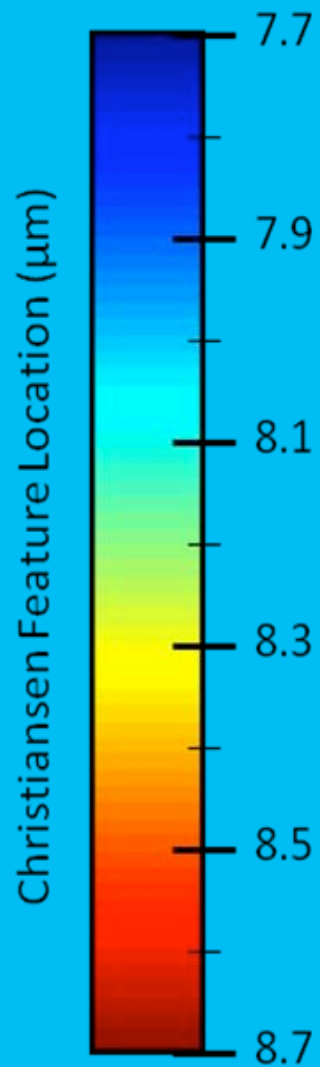
FeO (wt %)



- A-11
- A-12
- A-14
- A-15
- A-16
- A-17

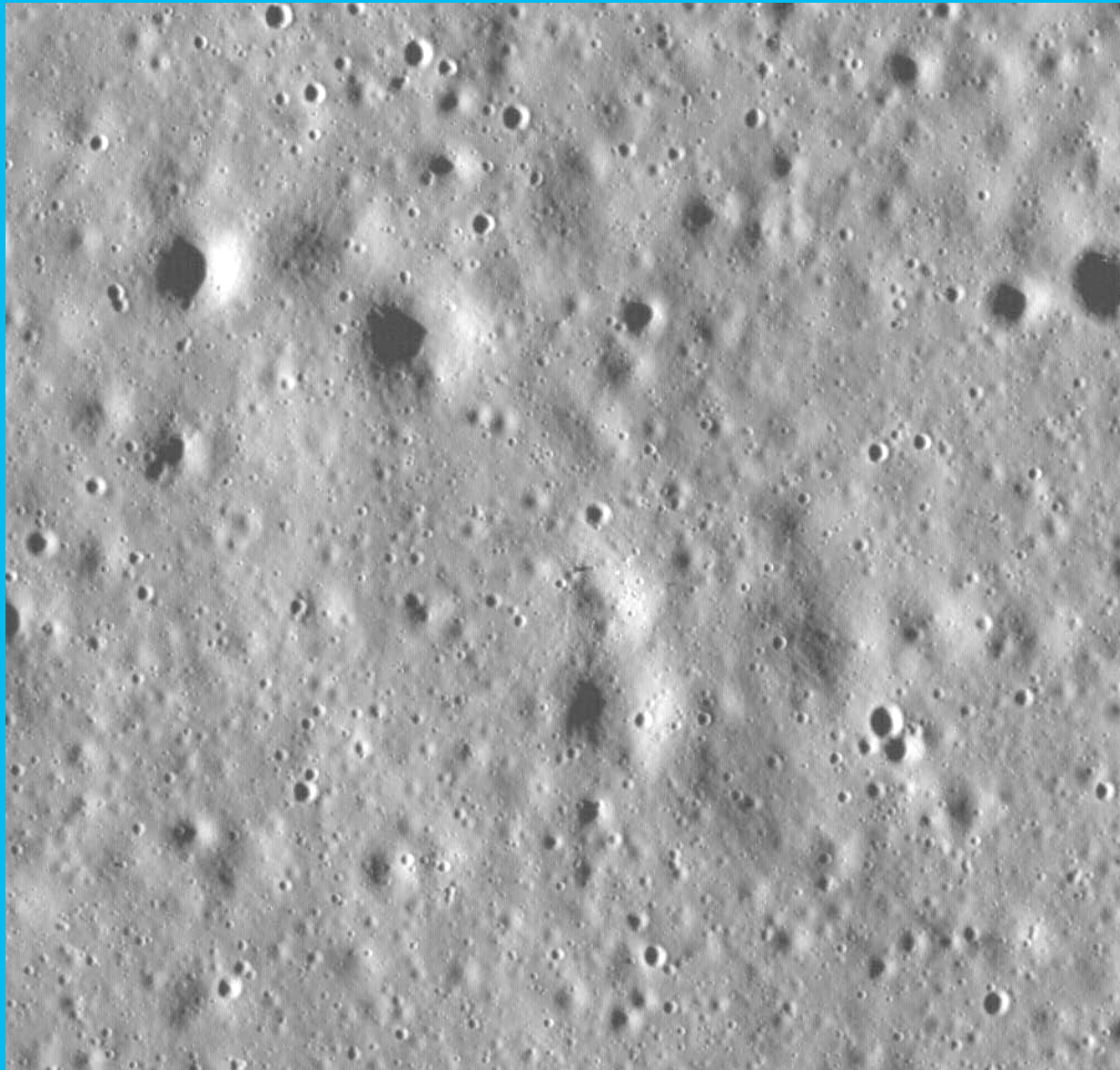






**Apollo site CF values are systematically higher than values from pure mineral spectra by  $\sim 0.1$**

**Soil maturity effect**



**Diviner CF  
peak locations  
are closely  
correlated to  
soil iron  
content and  
major  
mineralogy.**

**Peak locations  
are sensitive  
to local  
geology and  
soil maturity.**





**Stay tuned for  
Greenhagen *et al.*  
(talk # 4)**

**... extending  
these results to  
the entire Moon**

**Wyatt *et al.*  
(talk # 7)**

**... analyzing  
pure plagioclase  
regions**